

spaces between them. For example, as illustrated in FIGS. 2 and 4, two membranes 52 may enclose a space 60 such as a well or microwell between fluid paths 20, 30. Such an arrangement may be particularly desirable where the interaction to be observed between materials from each of flow paths 20, 30 would not be readily observable in a smaller volume.

[0079] Where convection controller 50 includes a space 60, such space 60 may be constructed in any manner and configuration that allows a desired volume to be generated or renders an interaction more readily observable. Typically, space 60 will have a length and width set to match contact region 40 and/or convection controller 50 and a depth set to provide the desired volume or to allow an interaction to be more readily observed. Increasing depth may make an interaction more observable by increasing the amount of the interaction that may be observed looking down the depth of space 60. For example, where an interaction produces luminescence or absorbance, the observed intensity of the luminescence or absorbance may be increased by increasing the depth of space 60. Depending on the embodiment, for a microfluidic system, space 60 may be less than 500 micrometers deep, less than 250 micrometers deep, less than 200 micrometers deep, or less than 100 micrometers deep. Space 60 may also vary in shape from contact region 40 and/or convection controller 50. For example, space 60 may include a well or microwell extending beyond contact region 40 and/or convection controller 50. Space 60 may be of any shape that provides the desired volume or renders an interaction more readily observable.

[0080] Convection controller 50 may be constructed from any material that sufficiently inhibits convection while allowing desired diffusion. A variety of materials are known in the art that inhibit convection and allow diffusion, in some cases such materials selectively exclude certain materials. For example, a variety of membranes, gels and filter materials are known that perform these functions. Many of these materials are polymeric materials, such as cellulose, cellulose acetate, polyamide, polyacrylamide, acrylonitrile, polyvinylidene, (sulfonated) polysulfone, nylon polypropylene, polyethylene, and polytetrafluoroethylene (PTFE). Another example of a suitable polymeric material that may be formed into a convection controller 50, such as a membrane, is polycarbonate. Polycarbonate is relatively inexpensive, durable and easy to work with and is capable of inhibiting convection while allowing diffusion through pores created within the material. A suitable polycarbonate membrane is available from Osmonics, Inc. of Minnetonka, Minn.

[0081] Microfluidic system 10 according to the present invention may be constructed using any method that will repeatably produce microfluidic system 10 having the desired structure and functionality. For example, microfluidic system 10, or portions of microfluidic system 10, may be constructed by conventional etching techniques known in the art. Preferably, microfluidic system 10 is constructed according to the methods described in "Rapid Prototyping of Microfluidic Systems in Poly(dimethylsiloxane)." *Anal. Chem.* 1998, 70, 4974-4984., "Fabrication of topologically complex three-dimensional microfluidic systems in PDMS by rapid prototyping", J. R. Anderson; D. T. Chiu; R. J. Jackman; O. Cherniavskaya; J. C. McDonald; H. K. Wu; S. H. Whitesides; G. M. Whitesides *Anal. Chem.* 2000, 72, 3158-3164., and a review "Fabrication of microfluidic sys-

tems in poly(dimethylsiloxane)", J. C. McDonald; D. C. Duffy; J. R. Anderson; D. T. Chiu; H. K. Wu; O. J. A. Schueller; G. M. Whitesides *Electrophoresis* 2000, 21, 27-40., which are hereby incorporated by reference in their entirety. The method described in this reference may be modified where required to accommodate the construction of convection controller 50. For example, convection controller 50 may be positioned between two layers of material containing fluid paths therein as part of aligning and joining the layers and bound to the material by conformal contact. Where a space 60 is desired within convection controller 50, space 60 may be constructed as a microwell in a layer and assembled as described in the above-referenced article.

[0082] In some instances, it may be desired to treat the edges of convection controller 50 with prepolymer prior to assembly and sealing of the fluidic system, particularly where the material convection controller 50 is constructed from varies from the material fluid paths 20, 30 are constructed into. Upon curing, the prepolymer may seal any gaps at the edge of convection controller 50, inhibiting leakage. FIG. 6 illustrates the leakage that may occur at the edge 52 of a membrane convection controller 50 without prepolymer, as seen with fluorescent dye. By contrast, FIG. 7 illustrates the lack of leakage at the edge 52 of a membrane convection controller 50 when prepolymer is added as described above. Areas other than the edges where leaks may occur, such as between fluid paths and around contact points, may be treated similarly. Materials other than a prepolymer may also be used to seal leaks as described above. For example, any material capable of forming a fluid seal and compatible with the fluids, fluid paths, and convection controller may be used.

[0083] Any type of fluids or other flowable materials may be introduced into fluid flow paths 20, 30. For example, fluids may include solutions, suspensions, flowable gels, slurries, and the like. While the fluidic system of the present invention may be used to promote interaction of any substances, in a typical use a first fluid path 20, or set of fluid paths, will contain a material to be tested, while a second fluid path 30, or set of fluid paths, will contain an indicator material. Test materials may include any material that may be desired to be interacted with another material to produce some observable result. Indicators may include any material that may interact with a test material to produce an observable result, such as a color change, pH change, generation of luminescence, precipitation, change in index of refraction, light scattering, or the like. It also should be appreciated that the fluidic system of the present invention may be used for any interaction of materials and such reaction need not be a "test."

[0084] Interactions promoted or performed by the arrangement of the present invention need not be limited to chemical reactions. For example, interactions based on forces such as bioaffinity and hydrophobicity or hydrophilicity may be performed. Some such interactions may be relatively complex. For example, a first fluid, such as an aqueous phase may be placed in a first flow path 20, a second fluid, such as a surfactant, may be placed in space 60, and a third fluid, such as an oil, may be placed in second fluid path 30. The first fluid may be forced through pores in a first membrane, entering space 60 as drops and being coated with the second fluid. The drops may then be forced through pores in a